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CONTENTS

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ORGANIC DETERMINISM[1]

OUR daily life is chiefly made up of an array of activities determined in the main by our surroundings. The heart beats more or less vigorously in accordance with an uphill or downhill course. White corpuscles move about in our bodies much as amoebae do in ponds and gather in regions of foreign invasion. Our eyes blink at the quick movement of even a friendly hand. Breathing adjusts itself as heart action does and rebels against a self-imposed restraint. Our daily habits become so ingrained that dressing and undressing, eating, going to our occupations and returning from them follow the course of the sun.

But human life is also permeated by a kind of action that calls for a certain measure of freedom. Our choices and volitions appear to us to be in many respects quite free, and this seems especially true the more we attend to this aspect of them. Such freedom is usually regarded as the basis of our social responsibilities, for a person can not be held accountable for that which he is unable to control. Any complete scheme of nature must include a consideration of what seems to be constrained and of what seems to be free in human action.

Our bodies are made up of some twelve of the approximate hundred elements recognized by the chemist and of these the principal ones are carbon, hydrogen, oxygen and nitrogen. These four elements and in fact all others found in living bodies occur in abundance in inorganic nature. In brief there is no element exclusively concerned with life. The chemical elements are further resolvable into electric units, protons and electrons, which in varying combinations give rise to these elements. How can a constitution such as this make clear to us the diversity of human action?

Such a constitution lends itself with comparative ease to the understanding of many metabolic processes as, for instance, those that occur in digestion and the like, the reflexes and the tropisms and many allied organic operations. But will it make clear the human capacity of imagination, of memory, will it serve to elucidate the emotions, the affections and such other factors in human life?

From this standpoint some of the older evolutionists are responsible for an interpretation of nature

[1] This address, from which certain passages were omitted in consequence of an overcrowded program, was read at the annual meeting of the American Society of Naturalists, held at Cincinnati, December 29, 1923.

that appears to be quite false. Recognizing, as they did, the remarkable character of the human mind and the fact that we were evolved from the simpler states of lower organisms, and ultimately from molecules, atoms and, as we would say nowadays, from electric units, they proceeded to endow these simpler states with diminishing amounts of the qualities so evident in the final product and to speak of the molecular mind, of the atomic mind and so forth. But of this view, early advanced by Haeckel and later advocated by Lloyd Morgan, there is not a vestige of supporting evidence. The chemist weighs and measures carbon, hydrogen, oxygen and nitrogen, combines these elements into complex compounds and decomposes such compounds again into their elements, and all with such conformity to law and order that he never for a moment finds it necessary to introduce the conception of an atomic mind to make clear the action of the materials with which he works. Such experimental variations as he finds he attributes to the shortcomings of his technique, and as long as these variations lie within the error of his method, he does not concern himself with them, a procedure that has a pragmatic justification. But after his laboratory experience he returns to his fireside to learn from his wife that she has changed her plans and that instead of remaining at home for a quiet domestic evening, as agreed upon at the breakfast table, she has bought tickets for the opera and he, poor man, must don evening clothes and escort her to town. Yet this wife, as the chemist knows full well, is the same carbon, hydrogen, oxygen and nitrogen that yielded him such uniform and consistent results in the laboratory. Surely this is a real contrast.

But, I hear some one ask, are human actions really as free as they seem to be? Are we not deceived in ourselves when we think we are free? This is by no means a simple question. Bergson and others have pointed out that our decisions depend much upon our past and that what seems to be a free present choice is as a matter of fact a step determined long ago. But such a proposal is no real solution of the question, for either it places the real act of choosing at some distant moment or it throws over the whole a cloud of obscurity through which no light can penetrate.

In approaching this problem we must divest ourselves of many of our preconceived notions, particularly of those that we have gathered from a study of purely lifeless nature. We must not be surprised if the kind of uniformity with which inorganic processes proceed should not reappear in its simplicity in the organic. The kind of test that applies satisfactorily to the inorganic may be insufficient for the organic. If an experimenter ask us to turn a given hand to the right or to the left that he may record in ten trials the number of turns in one direction or the other, we know perfectly well that it lies within our power to make all turns to the right or all to the left or some to the right and some to the left in proportion as we wish. We know further that we may decide on the outcome of the test much in advance or at the moment of action or we may even decide on one course and, in the midst of the operation, change to another. From a personal standpoint the freedom of turning the hand is unquestionable nor is the decision about such an act necessarily relegated to the past. Though many human operations are as circumscribed and mechanical as are the reactions in a test-tube, others, such as those just mentioned, show a certain degree of real freedom. "Men at some time are masters of their fates. The fault . . . is not in our stars but in ourselves." And Palmer, in discussing this problem, expresses much the same idea when he says, "the laws of determinism rule our lives more than the vitalist has been willing to believe. But we are free to choose between two alternative lines of necessity and to that extent at least our fates are in our own hands." And no less an authority than Huxley adds, "nobody doubts that, at any rate within certain limits, you can do as you choose." In my opinion, some human acts exhibit a limited amount of real freedom. To deny this is to fly in the face of fact.

I can not agree with Jennings that with less than this minimum of freedom social responsibility can really exist. Whether my hand goes into my own pocket or into my neighbor's may make all the difference between a moral act and an immoral one, and in the normal human being the freedom to decide in which direction the hand will go is, I believe, at times a real freedom. Disease or habit may prevent or remove this freedom, but that it exists under certain circumstances I have not the least doubt.

How can a freedom of this kind be thought of as a property of a body composed exclusively of such chemical elements as carbon, hydrogen, oxygen and nitrogen? The answer to this question is to be found, in my opinion, in the way in which these elements are assembled, in the organization of the compounds that they form. Who would suspect the properties of water from those of its component elements, oxygen and hydrogen? These two gases in no way suggest the liquid, water, with a maximum density four degrees above the freezing point, not to mention other physical properties. Yet we know that hydrogen and oxygen unite with a loss of energy to form water and that water with the absorption of energy may be resolved again into hydrogen and oxygen. This state of affairs is true of all other chemical combinations. The elements of which compounds are formed give no grounds for the prediction of the properties that the compounds show. This rule seems to hold in all

chemical reconstitutions. The properties of electrons and protons give no clue to many of the most conspicuous properties of the resultant atoms; nor do the peculiarities of given atoms foreshadow the characteristics of the molecules into whose composition they enter. Science may eventually discover what these relations are, but for the present it must admit that they are almost completely beyond range. In material evolution each step is marked by an abrupt and sudden change. Nature is not, as the older evolutionists would have us believe, a smooth ascent or descent in complexity, but each move is associated with abrupt alterations in which properties entirely novel and unpredictable appear. The changes suggest organic mutations such as biologists have been working with recently, and this resemblance may not be so superficial as at first sight it appears.

In fact, what goes on in the inorganic realm is abundantly met with in the organic. When organic molecules are assembled in a certain way they exhibit properties quite unlike those they show when they are brought together in another way. The same kind of food may be supplied to a cat and a dog with the result that there will be, not an increasing similarity between the two animals, but more cat and more dog, for in each case the added materials will be organized in a way peculiar to each animal. If it were possible to assemble in an appropriate fashion all the materials of which a given living organism is composed, their interaction would be such that life would immediately appear, for life is the expression of precisely such organization, just as the properties of water are the expression of a particular organization of hydrogen and oxygen. That living things have not been produced as water has is due to the enormous complexity of organisms and not to the necessary impossibility of the steps in the operation.

From separate organic compounds to organized living protoplasm we pass from one plane of organization to another and consequently from one set of properties to another. The essential properties of living protoplasm are at present no more to be understood from its constituent compounds than are the properties of water from those of hydrogen and of oxygen. The properties of living protoplasm are too manifold for description. They are those properties whereby living protoplasm acts otherwise than its chemical constituents do. They are as diverse as are the kinds of protoplasm. In specified forms of nervous protoplasm these properties include types of action in which a certain degree of freedom is involved, so that out of a given situation one of several possible and different lines of activity may result. This is the type of action that enables a person to turn his hand at will to the right or to the left. It is a type of action that determines its own direction. That this freedom is common to all living protoplasm is improbable. That it is the property of even all nervous protoplasm is unlikely. It appears to be characteristic of only certain kinds of nervous protoplasm. But that it is the property of such protoplasm seems beyond doubt.

This property disappears at once on the disorganization of the living nervous protoplasm that exhibits it. When thus disorganized such protoplasm breaks into its constituents, which in consequence of the change in organization exhibit very different properties as, for instance, those of lifeless bodies. Thus differences in organization are accountable for differences in properties in the organic and the inorganic alike.

According to this view a limited freedom of action results from a given organization. The activity may pass off over one of several possible courses instead of being restricted to a single course, as is common in the inorganic. The contrast between a single course and multiple courses may be made clear by a mathematical comparison. If we ask ourselves what constitutes two in any group of units, there is only one answer, namely, two units. But if we put the same question concerning ten, there are several answers, any one of which is equally true: a group of six plus a group of four, a group of seven plus a group of three, and so forth. The first condition typifies what is commonly met with in the inorganic, only a single possible course of action. The second condition represents what is found in certain kinds of nervous protoplasm, several equally possible courses. Thus, from a given state of nervous activity, rendered possible by the type of organization, one of several courses of action may be taken, the state of activity itself determining which course will be elected. This view contravenes nothing in the energetics of inorganic action. It merely extends the single course of action in the inorganic to several courses and sets the determiner as to which course will be elected in the process itself. This property of nervous protoplasm is at present no more to be explained than are other fundamental properties of material, such, for instance, as gravitation. Knowledge may eventually make clear to us the nature of these properties. At present they are open to observation and description rather than to explanation, if in fact explanation applies to such matters.

The view herein set forth is plainly not what Jennings and others mean by experimental determinism, for out of a given nervous activity may emerge any one of several lines of action without perceptual diversity preceding the given action. Within limits nervous activity determines its own direction. It exhibits what may be called limited indeterminism. This view is also not that expressed by Minot that con-

sciousness affects vital processes, for consciousness itself is a vital process and not an agent that influences vital operations from the outside. It is in the very midst of certain nervous activities and is as a matter of fact one aspect of them.

This view implies that the processes of nature are dependent upon the way in which natural elements are assembled and interrelated, that is, upon the way in which they are organized, for with each new plan of organization, be it from electron to atom, from atom to molecule, or from molecule to aggregate, a new type of action appears. The activities of each type of organization are peculiar to that type and are not, at present at least, predictable from the activities of the elements that enter into the new organization.

Is the view advanced in this address vitalistic or mechanistic? Within recent years all such general views have been put on one or the other side of the line supposed to separate these two fields. The authors of such views have suffered similar fates. They, too, have been ranged willy-nilly on one side or other of this imaginary line and often with incongruous and contradictory results. Some, however, are by their own confessions avowedly mechanists, others vitalists. But this has not prevented classifiers from arranging them quite differently. At times this matter has risen almost to the level of personalities. For a vitalist to call another a mechanist or the reverse seems to be a source of great relief to certain pent-up natures. Then, too, there are those who in conformity to the freedom argued for in this paper have taken the liberty of changing sides and after having been for a while advocates of one view have subsequently gone over to the other. Consequently, much confusion exists and, as Jennings says, persons holding the same views rally to different battle cries, while those with diverse opinions march in supposed alliance.

What constitutes the mechanistic view is not easy to say. Newton expressed the hope that the laws of celestial mechanics would eventually find application to all nature, including living things. Growth in this direction has been the characteristic of Loeb's mechanistic studies. These afford a safe basis for experimental research and require no defense such as Jennings has recently made for experimental determinism, and Neal for vitalism. It is plain, however, that the view advanced in this address includes more than the orthodox mechanism of to-day will allow. It is, however, conceivable that the modern mechanistic view may expand, as in fact it has done in the past, and absorb this and all other like views.

It is also equally plain that the view herein expressed falls short of the requirements of even a moderate vitalism. In his defence of this doctrine Neal states that human experience includes phenomena without spacial attributes and implies that these are the peculiar subject-matter of vitalism. No such elements are involved in the doctrine advanced in this paper. According to this view no entelechy slows up or hastens on the processes of living nature. Neither does a psychoid nor an elan vital find a lodgment in this scheme. Types of organization, not the addition of new elements, characterize this view and in this sense remove it from the pale of vitalism.

Mast in a recent paper has intimated that a declaration in favor of vitalism or of mechanism would be premature at the present time. This statement carries with it the implication that one or other of these views will eventually prevail. But in my opinion, in addition to vitalism and mechanism, there may be a tertium quid, or, if I may be allowed such expressions, possibly a quartum or even a quintum quid. The view advanced in this paper is some one of these. It is not the animism of such psychologists as McDougall nor does it agree with Bertrand Russell's opinion that the universe is composed of something in nature between thought and material. If it must be named, it might be called organicism, to use a term introduced about a century ago and recently revived by J. S. Haldane. But it is not Haldane's organicism, for this is based on his belief that the world with all that lies within it is a spiritual world. It is a materialistic view which, however, recognizes in certain types of organized matter a degree of free action consistent with human behavior and the resultant responsibility.

G. H. Parker
Harvard University

Postscript: Since this address was read, the author's attention has been called to two recent books in which much the same principle that has been advanced in these pages has been independently advocated. They are R. W. Sellars's "Evolutionary Naturalism" (Chicago, 1922), and C. L. Morgan's "Emergent Evolution" (New York, 1923). It is evident from the latter volume that Morgan has profoundly changed his views as compared with those attributed to him in this address and taken from his "Comparative Psychology" (1894).

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THE BARRO COLORADO LABORATORY

I HAVE just returned from two months' work on Barro Colorado Island, the site of the new station for tropical research in Gatun Lake, C. Z. Barro Colorado Island was the largest of the old hills rising above the valley of the Chagres River and consequently is now the largest of the islands in the man-made Gatun Lake. It is located about an hour's ride, either by outboard motor or by native boatman, from Frijoles which in turn is about an hour by train from Panama City. One can commute from civilization at Ancon and spend from 9:15 to 3:30 on Barro Colorado.

Comfortable living quarters have just been erected and equipped on the island so that a small party can now live and work with comfort in the jungle itself.

The jungle spreads over the five square miles of the island without natural openings. It is more dense on the more distant southern side than around the new building. The lower slopes of the hills around the margin of the present island were formerly under cultivation to a considerable extent and on the far side a few hectares are still under cultivation although all such work by natives is now a thing of the past. Remnants of the plantings of bananas, oranges, limes, guava, etc., are still encountered in the bush and the abandoned sites of several native huts can still be distinguished.

There has been some chopping above the cultivated region but, to all appearances, the central and higher part of the island is virgin although one hesitates to state that it has not been cut over in the four centuries during which the isthmus has been occupied by white people.

The jungle is of the rain forest type but its height and density is of course affected by the fact that the rainfall is only about a hundred inches annually. The usual height is about a hundred feet to the main jungle roof which is overtopped by scattered trees. The growth is so dense that one can rarely obtain a good view of the lake even from the hillsides near the water. On the southern side much machete work is necessary in order to make one's way, but on the northern side the growth is more open.

The "laboratory" just finished is admirably equipped for living in the jungle and to serve as a base for collecting and for field observations. It can readily be used for extended and much-needed studies in tropical life histories of animals living in rapid streams and in Gatun Lake as well as of the jungle animals themselves.

Ants and termites are the most conspicuous insects and offer excellent opportunities for the study of habits and for the collecting of commensals. Several new species of the latter have been taken in the short time since work began about the laboratory. *Peripatus* also occurs on the island, although it is not easily come by in the dry season, and the general physiology of this much talked of animal can be studied here.

The birds are the most noticeable of the higher animals, with lizards a close second. There is much need of life history work on these groups both of the older natural history type and of the newer type of studies into the physiological requirements during different stages of development.

Armadillos, conejos, nequis, peccaries, raccoons, night monkeys, white faced monkeys, and black howling monkeys are common and relatively tame. Tapirs, large cats and deer are also known to occur. Sloths, anteaters, etc., are found nearby and are probably on the island.

The station also affords an opportunity for the study of the physical conditions under which animals live in this sort of jungle and for comparison with life conditions in the dryer regions on the Pacific coast and the more moist jungles of the Atlantic side. In connection with such studies or independent of them one can readily work out the local distribution and association of animals in the manner that has become fairly standardized in making ecological surveys in temperate regions.

Probably the greatest value of this new station for

biological research lies in its ready accessibility and its nearness to the highly civilized cities of the Canal Zone. Perhaps after a taste of the tropics here and an introduction to tropical conditions and methods more zoologists will desire to venture into the less accessible tropical regions.

Official information concerning the facilities available at Barro Colorado Island can be obtained from the resident custodian, Mr. Jas. Zetek, Ancon, C. Z., or from Dr. Thos. Barbour, of the Museum of Comparative Zoology at Harvard. I shall be glad to answer personal inquiries to the best of my knowledge.

W. C. ALLEE

DR. WILLIAM JAMES BEAL

DR. WILLIAM JAMES BEAL died on May 12, at the home of his daughter, Mrs. Ray Stannard Baker, Amherst, Mass.

Dr. Beal was in his ninety-second year, the oldest citizen of his town and the oldest graduate of his college, the University of Michigan. He was also one of the earliest students of Louis Agassiz at Harvard College. He had a long and honorable career, having been for over fifty years a teacher of science, at an early time at the University of Chicago and later, for forty years, he was professor of botany at the Michigan Agricultural College. He wrote a number of important scientific works, the chief of which was an exhaustive study, in two volumes, of the "Grasses of North America," which remains a standard work upon that subject.

He was a pioneer in the new methods of scientific education, having gone to Harvard College after his graduation from Michigan University, where he studied under Agassiz and Asa Gray, and was in one of the early classes in chemistry taught by President, then Professor, Eliot. He took his degree at Harvard in 1865. He was one of the earliest teachers to use the laboratory methods of Agassiz. His "New Botany," published in 1881, inspired many a younger teacher of science. Not a few of his students have become distinguished botanists, horticulturists and foresters. He was an indefatigable worker, with the habit, almost the passion, for independent observation and study. He was like a child eager to open each new package that Nature presented, to see what it contained. He rarely passed a tree or a shrub or a flower without turning to see the other side of it. He infected his students with this enthusiasm to know nature, and to know at first hand. He had certain maxims which he kept constantly before them. Here are some of them:

"Merely learning the name of a plant or parts of a plant can no longer be palmed off as a valuable training."

"In the whole course of botany, the student trains for power more than for knowledge."

"Details and facts before principles and conclusions."

"An eye trained to see is valuable in any kind of business."

Dr. Beal was not only a careful and thorough scientist, but he had a keen interest in spreading scientific knowledge through organizations of every kind. He was one of the organizers and the first president of the Society for the Promotion of Agricultural Science, he was director for some years of the Michigan State Forestry Commission, he was president of the Michigan State Teachers' Association and an energetic member of the Botanical Society of America, the American Pomology Society, the American Association for the Advancement of Science and other similar organizations. He had degrees from three universities and was awarded honorary doctors' degrees by the University of Michigan, the Michigan Agricultural College and Syracuse University.

But among the students who passed through his classes in fifty years—and they were a legion—it is doubtful whether he had more of influence as a scientist or as a man. For he had qualities of unremitting industry, sincerity of mind, simplicity of habit, together with a characteristic dry humor, which left an indelible impression upon every one with whom, especially at the zenith of his long life, he came into contact. He was of pioneer Quaker stock, born in Michigan in 1833, when it was still a wilderness. He had to fight for an education, working every step of his way through one school after another, beginning with a backwoods seminary and keeping at it until he found himself studying marine biology with Louis Agassiz at Harvard and corresponding with Charles Darwin. He lived all his life with a kind of Spartan simplicity. He not only never used liquor or tobacco, but never drank tea or coffee. He always left the table when, as he said, "he could relish half as much more." He began early, when such things were rare in college, the deliberate and habitual practice of exercising, insisting until he was nearly ninety years old in running a few hundred yards every day, or sawing so many sticks of wood.

"I studied and labored industriously," he said, "because it gave me joy."

He was of a cheerful disposition, and his old age was full of tranquillity and happiness. He spent the last fourteen years of his life in a garden of Amherst. He was ill only three days before his death and even during that time suffered little. At the very last, when asked how he was, he remarked, "Getting better." He died peacefully in his sleep.

He leaves one daughter, Mrs. Ray Stannard Baker, four grandchildren and one great grandson. He will rest in the family cemetery near the scene of his long labors, at Lansing, Michigan.

R. S. B.

SCIENTIFIC EVENTS

EXHIBITS AT THE CONVERSAZIONE OF THE ROYAL SOCIETY

The first of the two *conversaziones* given annually by the Royal Society was held at Burlington House, London, on May 14.

The exhibits included, according to the London *Times*, one by Professor Gerald Stoney and Mr. J. P. Chittenden, showing the vibration of steam turbine discs and shafts. In one model, a multi-loaded shaft was rotated up to 4,600 revolutions a minute or more. In the same room the Anglo-Persian Oil Company showed an experimental apparatus used in investigating the protection of oil tanks from lightning. In an adjoining room the National Physical Laboratory had two exhibits—one a mercury-vapor pump, designed to combine the jet and condensation principles in one unit and able to produce a vacuum of 0.00001 mm of mercury or less when working against a back pressure of 1 mm; and the other a method of measuring natural lighting in rooms. In a third exhibit from the laboratory, an electrical method of hardening the ends of standard gauges was demonstrated.

Among other physical exhibits, Professor E. N. da C. Andrade and Mr. J. W. Lewis had an apparatus for showing the vortex motion of viscous liquids between two rotating cylinders; the Cambridge Instrument Company sent a torsionmeter in which an ammeter gives a direct reading of the mean torque over a 4 ft. length of shaft of any diameter; a new type of isothermal calorimeter came from the Explosive Branch, Research Department, Woolwich; and apparatus sent by Professor W. A. Bone included a nickel-steel bomb capable of withstanding pressures up to 1,000 atmospheres suddenly developed in gaseous explosions. There were two applications of the neon lamp—one a device for measuring peak voltage, shown by Professor J. T. MacGregor-Morris and Mr. L. E. Ryall, and the other, a method, developed by the International Western Electric Company, of producing an even time-scale for the inspection of wave-forms with the cathode-ray oscillograph. A recently discovered wax portrait of Joseph Priestley, in high relief and colored as in life, and also the original pocket-sundial of the Earl of Orrery, were exhibited by Mr. George H. Gabb.

The biological exhibits were unusually numerous, among the contributors being the Departments of Zoology of the British Museum and the Imperial College of Science and the Royal College of Surgeons. A method permitting cell division to be studied in the living tissue was shown by Mr. T. S. P. Strangeways, and Mr. B. K. Das illustrated the development in certain Indian fishes of accessory breathing organs in addition to the gills. Living specimens of plants from Rothamsted Experimental Station showed the effects of absence of boron on the growth of various species. In some cases the presence of this element in very minute quantities appears to be essential for perfect development, though an excess is harmful. Cultures of fungi that cause dry rot in buildings were shown by Professor Percy Groom. Sir Almroth Wright, with Mr. A. Fleming and Dr. Colebrook, demonstrated methods for the exploration of bacterial disease.

A GEOLOGICAL FIELD TRIP

The members of the department of geology of the Mississippi Agricultural and Mechanical College have under serious consideration the repeating of the department's summer field trip in automobiles. Instead of an Appalachian trip, as of the last two summers, the one contemplated this year is to the Pacific Coast by a southern route, thence north through California, Oregon and Washington, and home by a northern route.

The trip of last summer was more extensive than the one of the previous season. It covered approximately 5,000 miles and included a study of 22 states, the District of Columbia and the Dominion of Canada. The whole of the Piedmont belt, from Montgomery to New York City, was traversed, the New England highlands and coast to York Harbor in Maine, the White and Green Mountains of New Hampshire and Vermont, the drumlins of Central New York, the Pleistocene lake shores to Niagara Falls and Cleveland, the glacial till plains to Columbus, Indianapolis and Vandalia, and the Mississippi embayment of the Gulf Coastal Plains from Cairo to A. and M. College. Many kinds of metallic and non-metallic minerals of economic value were studied as they were being produced; as, for example, the coal, iron and flux of the Birmingham district; the bauxite and fuller's earth of Central Georgia; the barite, yellow ochre, manganese, brown iron ore and marble of the Atlanta environs; the clay products of Baltimore; the anthracite of eastern Pennsylvania; the zinc and other ores of Franklin Furnace, New Jersey; the granites of Quincy, Massachusetts; the quartzites of Vermont; the rock salt of New York, etc. Exhibits of minerals, rocks, fossils and the like were examined at many places but more particularly at the museums at Tuscaloosa, Atlanta, Richmond, the National, the University of Pennsylvania, the American, at Harvard, Albany and Ohio State University.

Not all geologic but none the less interesting and profitable were the many "side issues." They consisted of visits to 26 institutions of higher learning, southern, eastern, New England and central states—

Alabama, North Carolina, Annapolis, Johns Hopkins, Pennsylvania, International Correspondence School, Columbia, Yale, Brown, Massachusetts Institute of Technology, Harvard, Syracuse, Western Reserve, Case, Oberlin, Ohio Wesleyan, Ohio State, etc.; to the Southern Memorial at Stone Mountain and Lincoln Memorial in Washington; to Mount Vernon and Arlington; to Valley Forge, Lexington and Concord; to Independence Hall, Faneuil Hall and Old North Church; and to the homes of O. Henry, Wilson, Longfellow, Hawthorne, Emerson, Alcott, Harding and Riley.

The party consisted of Professor W. C. Morse, Associate Professor F. E. Vestal, one graduate student, now in the University of Chicago, and eight undergraduates. The trip was made in two high-speed, one-ton Ford trucks, one equipped with four seats, the other with the three rear seats removed for baggage and camp outfit. Transportation cost—gasoline, oil and maintenance—was fifty dollars for each person.

W. C. M.

SYMPOSIUM ON ABSORPTION OF THE ITHACA MEETING OF THE AMERICAN CHEMICAL SOCIETY

At the Washington meeting the Executive Committee of the Division of Industrial and Engineering Chemistry decided to hold a symposium dealing with "Absorption" when the society meets in Ithaca from September 8 to 13. The following is a very tentative outline of the proposed program of the symposium.

There will be one or more papers dealing with the mechanism of absorption, two or three papers describing experimental work which confirms the theory as to the mechanism of absorption, a paper showing the application of this theory to commercial installation, three or four papers dealing with commercial absorption equipment and one or two papers which will emphasize the industrial chemical side of absorption.

Professor Walter G. Whitman will act as chairman of this symposium. Already he has been able to secure promises from several prominent authorities to present papers before this symposium. The attention of the members of the society is called to the fact that completed papers, not to exceed 3,500 words, must be in the hands of the chairman of the symposium or the secretary of the division on or before the first of August. The papers are then submitted to reviewers and only upon a favorable recommendation are the papers placed upon the final program. An abstract not to exceed 200 words should accompany each paper.

Chemists who are working in any of the many applications of the field of absorption should get in touch with Professor Whitman at their earliest convenience. His address is Massachusetts Institute of Technology, Cambridge, Mass.

ERLE M. BILLINGS,
Secretary, Industrial Division

DR. GEORGE E. DE SCHWEINITZ

In accepting the resignation of Dr. George E. de Schweinitz as professor of ophthalmology in the medical school of the University of Pennsylvania, the following resolution was adopted by the trustees:

"RESOLVED: That the trustees accept with the deepest regret the resignation of Dr. George E. de Schweinitz as Professor of Ophthalmology in the School of Medicine, and instruct the secretary to prepare, in conjunction with Dr. LeConte, a suitable minute expression to Dr. de Schweinitz the gratitude of the trustees for his long and distinguished service to the university and to science."

Minute concerning the resignation of Dr. George E. de Schweinitz:

"Graduate from the Medical Department in 1881; resident physician in the hospital October 1, 1881 to October 1, 1882; surgical registrar, 1883-85; quiz master in therapeutics for five years; prosector of anatomy for Dr. Leidy, 1883-88; lecturer on medical ophthalmology, 1891 and 1892; professor of ophthalmology 1902 to date. As a teacher he has no superior; as a writer he has profound influence throughout the medical world. A recipient of the highest national and international honors from his confrères, he has achieved the ranking position in this country in his speciality. The luster of his accomplishments in life have been valued by him only as a means of ever increasing his service to the university, and of the forty-five years of close association with it, he gave constantly and freely of the best that was in him. The Board of Trustees is deeply grateful for such long and honored service."

SCIENTIFIC NOTES AND NEWS

The birthday honor list of the king of England includes the conferring of the Order of Merit on Sir Charles Sherrington, Waynflete professor of physiology at the University of Oxford, and a baronetcy on Sir Humphry Davy Rolleston, president of the Royal College of Physicians, London.

PROFESSOR J. C. MCLENNAN, of the University of Toronto, has been elected president of the Royal Society of Canada.

At the meeting of the Royal Society on May 15, the name of Mr. Henry Balfour, curator of the Pitt Rivers Museum, Oxford, was added to the list of elections of the society, the list of selected names having been reduced to fourteen by the death of Dr. T. Nelson Annandale.

PROFESSOR RUDOLPH MARTIN, professor of anthro-

pology in the University of Munich, will celebrate his sixtieth birthday on July 1.

DR. DAVID CHEEVER, of the Harvard Medical School, is retiring from the department of anatomy in order to give more time to his surgical work. His place will be filled by Dr. Robert M. Green, who will have Mr. J. C. McCann as an associate.

DR. F. L. RANSOME tendered his resignation as geologist in the U. S. Geological Survey, effective on May 16, in order to continue his present work as head of the department of geology and mineralogy of the University of Arizona.

PROFESSOR A. J. HILL, of the department of organic chemistry of Yale University, has been appointed a member of the Committee on Medicinal Products Research of the National Research Council.

DR. LILIAN WELSH, for thirty years professor of physiology and hygiene at Goucher College, was given the honorary degree of LL.D. at the annual commencement exercises on the occasion of her retirement from active teaching. Dr. Welsh becomes professor emeritus.

DR. ANATHAN AALL, professor of philosophy and director of the institute of psychology in the University of Christiania, has been appointed visiting professor of philosophy at Columbia University for 1925.

AT the fifth annual meeting of the Southwestern Division of the American Association for the Advancement of Science, the following officers were elected: *President:* Dr. Elliott C. Prentiss, El Paso, Texas. *Vice-president:* A. L. Flagg, Phoenix, Arizona. *Executive Committee:* A. L. Flagg, Phoenix, Arizona, *Chairman*; Professor Frank E. E. Germann, Boulder, Colo.; Dr. Byron Cummings, Tucson, Arizona; Dr. E. L. Hewett, Santa Fé, New Mexico; Dr. D. T. MacDougal, Tucson, Arizona; R. S. Trumbull, El Paso, Texas. *Secretary-Treasurer:* R. S. Trumbull, El Paso, Texas. The next meeting, of which the date is not yet announced, will be held at Boulder.

ATHERTON SEIDELL, of the Hygienic Laboratory of the Public Health Service, left for Europe on May 3. He expects to spend some time at the Pasteur Institute in the laboratory of Professor Gabriel Bertrand, where he will continue his studies of the vitamins. Dr. Seidell will attend the meeting of the Société Chimie Industrielle at Bordeaux and the International Union of Pure and Applied Science at Copenhagen.

DR. ALEXANDER G. RUTHVEN, of the University of Michigan, is spending two months in England to study museum methods at the British Museum in London, and to make arrangements with that institution for an exchange of materials.

PROFESSOR DONALD REDDICK, of the department of plant pathology of Cornell University, is spending his sabbatic leave in Europe. He plans to trace the development of plant pathology in Europe, and will also visit several universities on the Continent for purposes of general inspection and study.

DR. B. T. SIMMS, professor of veterinary medicine at the Oregon Agricultural College, has returned to the college after spending a month in investigation of the foot and mouth disease situation in California. Dr. Simms was a member of a committee appointed by Walter M. Pierce, governor of Oregon, to investigate the situation and report progress made in stamping out the disease.

M. L. CROSSLEY, of the Calco Chemical Company, Bound Brook, N. J., has been elected president of the American Institute of Chemists.

DR. H. E. BABCOCK, of Cornell University, has been elected president of the New York State Agricultural Society.

OSCAR LEE DUSTHEIMER, professor of mathematics and history at Baldwin-Wallace College, was elected president of the Cleveland Astronomical Society at its recent annual meeting.

DR. WILLIAM F. PETERSEN was elected president at the annual meeting of the Pathological Society of Chicago, on May 12.

I. L. MILLER, state food and drug inspector, has been elected president of the Indiana Section of the American Chemical Society.

PROFESSOR W. J. SOLLAS, professor of geology and paleontology in the University of Oxford, was elected vice-president of the British Paleontographical Society, to succeed the late Professor Bonney at the seventy-seventh annual meeting held in London on May 2.

DR. ERNEST CARROLL FAUST, who has exchanged chairs in helminthology during the year 1923–24, with Dr. William Walter Cort, of the department of medical zoology of the Johns Hopkins School of Hygiene and Public Health, is returning to Peking, on July 31, to resume his duties in charge of the division of parasitology in the Peking Union Medical College, under the China Medical Board of the Rockefeller Foundation. Dr. Faust plans to continue his investigations on the biology and epidemiology of parasitic diseases in China, particularly those communicated to man through the consumption of uncooked fish.

DR. WALTER F. RITTMANS, of the Carnegie Institute of Technology, has been appointed consulting engineer to the State of Pennsylvania.

Dr. Paul E. Howe, associate in the department of animal pathology of the Rockefeller Institution, at Princeton, N. J., has been appointed biological chemist in the Animal Husbandry Division, Bureau of Animal Industry, U. S. Department of Agriculture. Dr. Howe will assume his new work on June 16, and will have supervision of the nutrition investigations in animal husbandry.

L. I. Shaw has resigned from the U. S. Bureau of Mines to take a position with the Western Electric Co. He assumed his new work at the Hawthorne plant early in June.

Dr. W. A. Taylor, of the Chemical Warfare Service, has been appointed chemical director of the LaMotte Chemical Products Company.

Dr. Lee de Forest was declared on May 5 by the District Court of Appeals in Washington as entitled to priority as the inventor of the audion as a means of producing sustained electrical oscillations in transmission by radio or otherwise, the opinion of the court having reversed the finding of the commissioner of patents.

Dr. Herman A. Spoehr, of the Carnegie Institution of Washington, recently gave the annual lecture before the societies of Sigma Xi and Phi Beta Kappa, of the University of Nebraska. His subject was, "Sunlight the prime mover of civilization."

On May 21, Dr. William Crocker, director of the Boyce Thompson Institute for Plant Research, Inc., lectured before the Phi Kappa Phi fraternity of the University of New Hampshire, on "Building a modern plant research institute," and, on May 22, before the New Hampshire Academy of Science at Randolph, on "Interesting things I have learned from twenty years' research on seed germination." He was made an honorary member of Phi Kappa Phi on the occasion of the first address.

Dr. Albert Schneider will give a course of lectures on "Modern methods of crime investigation" at the regular summer session of the University of California beginning on June 23.

Professor Leonor Michaelis, of the Universities of Berlin, Germany, and Nagoya, Japan, lectured on the "Significance of colloid chemistry in medicine" at the Mount Sinai Hospital on May 29.

A correspondent writes: "Dr. George Little, state geologist of Mississippi from 1868–72, and of Georgia from 1874–81, died at his home in Tuscaloosa on the night of May 15, aged eighty-six years. Dr. Little was well known to the geologists of a generation ago. He met Sir Charles Lyell in Tuscaloosa in 1846, and Alexander von Humbolt in Germany in his student days."

Dr. C. Le Roy Meisinger, of the U. S. Weather Bureau, was killed on June 3, near Monticello, Ill., through the explosion of the balloon in which he was making the ninth of a series of flights to collect data in regard to storms at close range. Dr. Meisinger was twenty-nine years old.

Edward Clapp Shankland, the well-known civil engineer of Chicago from 1911 to 1916, died on June 4, aged seventy years.

Dr. Charles William Andrews, F.R.S., assistant keeper of geology in the Natural History Museum, Kensington, died in London on May 25, at the age of fifty-eight years.

On the occasion of the celebration of the centenary of the birth of Lord Kelvin, which will be held at Glasgow University on Commemoration Day, June 25, Dr. Alexander Russell, F.R.S. (an old pupil of Lord Kelvin), the president of the Institution of Electrical Engineers, will give the memorial oration.

A bronze tablet in memory of the late Professor William E. Kellicott was presented to Goucher College by the class of 1918, and unveiled at their class reunion on May 30. Professor Kellicott was the honorary member of this class. The speech of presentation was made by Miss Helena Schneidereith, president of the class, and President W. W. Guth received the gift for the college. The inscription upon the tablet is as follows:

AS A TRIBUTE TO
WILLIAM ERSKINE KELLICOTT
1878–1919
Professor of Biology in Goucher College
1906–1918
This Tablet is Dedicated
In Love and Honor to One Who Was Ever
An Inspiration as Man, Scientist, Friend
By the Class of 1918
Esse Quam Videre

A correspondent writes, "On May 18, in the large dome of the Chabot Observatory, Oakland, California, the twenty inch refractor, which cost in 1915 about $20,000, was dedicated as a memorial to Charles Burckhalter, who was for many years director of the Chabot observatory. This dedication was accomplished by the unveiling of a plaque, authorized by the Board of Education of the city of Oakland, as an expression of appreciation of the long faithful and distinguished service in the unique position which the city astronomer of Oakland holds. No other city in the world possesses as part of its public school system an observatory with an equipment equal to that in the Chabot observatory of Oakland. The present building though incomplete and the great telescope

are largely the result of the tireless efforts of Charles Burckhalter through many years. The plaque placed upon the pier of the 20-inch telescope contains a medallion of Mr. Burckhalter and these words: 'This telescope is dedicated to the memory of and named for Charles Burckhalter, director of Chabot Observatory, 1885–1923, by the Oakland Board of Education. He devoted his life to the youth of Oakland that they might know eternal truth as it is written in the stars. "The heavens declare the glory of God, the firmament showeth His handiwork."' At the unveiling of the plaque, Mr. J. F. Chandler, of the Board of Education, presided. Mr. Fred M. Hunter, superintendent of the Oakland Public Schools, spoke upon 'Mr. Burckhalter as a teacher.' Professor Earle G. Linsley, of the department of astronomy, Mills College, and director of the Chabot Observatory, spoke upon 'Mr. Burckhalter and the Observatory,' and Dr. Robert G. Aitken, acting director of the Lick Observatory, spoke upon 'The life work of an astronomer.'"

FUNDS have been provided by the National Tuberculosis Association for the support of research on the chemistry of tubercle bacilli at Yale University this coming year. The research is to be under the direction of Professor Treat B. Johnson, of the Sterling Chemistry Laboratory. The new appointees who will cooperate in this work are: Mr. Robert De Wolf Coghill, Ph.D. (Yale '24), research fellow, and Mr. Donald Mulvaney Hetler, M.S. (Kansas '23), who has been awarded a fellowship in biochemistry.

THE corner-stone of the building for the newly established Research Institute in Animal Pathology of the Royal Veterinary College was laid by the Duke of Connaught on May 23.

AT the annual general meeting of the Institute of Physics, held on May 26, Sir Charles A. Parsons, K.C.B., F.R.S., was reelected president. The vice-presidents are Professor W. H. Eccles, F.R.S., Mr. C. C. Paterson, Dr. E. H. Rayner and Sir Napier Shaw, F.R.S. Sir Robert Hadfield, F.R.S., is treasurer, and Professor Alfred W. Porter, F.R.S., honorary secretary. From the annual report of the institute it appears that the demand for highly trained and qualified physicists exceeds the supply. The report deals at some length with the new monthly *Journal of Scientific Instruments* which is being produced by the Institute and edited at the National Physical Laboratory. It also refers to the lectures on "Physics in Industry" which are being delivered under the auspices of the institute and a second volume of which will shortly be published by the Oxford University Press. It is believed that the publication of these lectures and their circulation among manufacturers will do much to promote one of the main objects of the Institute, which is to urge the importance of physics in industry, and to encourage the employment of physicists qualified to understand where and how physical principles and knowledge may be utilized in increasing the efficiency of existing processes, and in the development of new applications.

Nature writes research and education will benefit by the surplus of just over £780, which the local committee organizing the Liverpool meeting of the British Association has realized from receipts for excursions, subscriptions, etc. Subject to the approval of subscribers, the money will be allotted as follows: £300 to the Tidal Institute of the University of Liverpool towards the fund which is being collected for the purchase of a tide-predicting machine; the profits from the exhibition of scientific apparatus, with an additional sum to make £200, to the Technical and Commercial Education Sub-Committee of Liverpool for the endowment of a prize called the British Association Exhibition, to be awarded annually in the Central Technical School; and the balance to a fund to assist scientific workers from Liverpool to attend meetings of the British Association in the British Isles.

AMONG the courses offered at the summer school of the New York State College of Agriculture at Cornell University to deal with forestry, and particularly designed to meet the needs of teachers, one is a course in popular dendrology; its object is to acquaint those who elect it with the more common trees of New York State. The other course outlines the field of forestry, with especial emphasis on those phases of the subject concerning which every intelligent person should be informed. The aim in both courses is to present material that will be of value to teachers in their work in their own schools. In 1924 these courses will be conducted by Professor Ralph S. Hosmer, head of the department of forestry at Cornell University.

A CORRESPONDENT writes: "A fossil harbor seal or 'hair seal' about two feet in length has been sent to the Museum of Stanford University, by Mr. Edward B. Starr, from the diatom beds at Lompoc. These beds belong to the Miocene age and are supposed to be about two million years old, and this specimen, very perfect, is the first fossil of the kind which has been found in the regions bordering the Pacific Ocean."

Industrial and Engineering Chemistry states that the Treasury Department has adopted a new list of standards of strength of coal-tar dyes. This list is a revised and enlarged edition of the tentative list issued by the Treasury Department on August 14, 1923, and is in accordance with a proviso of Para-

graph 28 of the tariff act, which provides that the specific duty of 7 cents per pound on finished coal-tar dyes shall be applied on the basis of strength of commercial imports prior to July 1, 1914, since pre-war period dyes generally were imported in lower strength than now. The revised list contains 469 standards, covering about 1,100 names of dyes, whereas the original list consisted of 212 standards covering 600 names of dyes. New features are Schultz and Color Index numbers, where there are any, or letters indicating the method of application for each dye; a general index; and keys to the class index and the manufacturer's name. These standards represent approximately ten months' work by the customs service in cooperation with domestic manufacturers, importers and coal-tar experts, and are the result of many laboratory tests made in New York. The list was submitted to large importers and domestic manufacturers for comment, criticism and correction. As a result, some dyes were eliminated where doubt existed; others, where objection did not appear sound, were retained.

Dr. H. W. Wiley attended the semi-centennial celebration of the opening of Purdue University recently held at Lafayette, of whose first faculty he is the sole survivor. Thirty-seven students were present on the first day, September 17, 1874. Of those, seven failed to qualify. Now there are over 3,000 students enrolled, and Purdue has reached the hegemony of the land-grant technical schools. During the celebration Dr. Wiley spoke to the Purdue Club, the Tippecanoe County Medical Society, at the semi-centennial dinner, and to the Lincoln Club of Lafayette of which he was a former member in 1880 and its first president.

UNIVERSITY AND EDUCATIONAL NOTES

The sum of $500,000 has been given to the University of Alberta Faculty of Medicine, Edmonton, by the Rockefeller Foundation of New York City.

The Rockefeller Foundation has also provided for a period of five years funds for the development of the Medical School of the American University of Beirut, Syria, of which Mr. Bayard Dodge is president. The appropriation provides for new fellowships, laboratory equipment and medical periodicals. It is proposed to place the medical school on a par with medical institutions of class A in America and Europe.

A gift of a million dollars has been made to the University of Paris for the erection, in the so-called University City, of a house primarily for Belgian students, and secondarily for students of Limburg and Luxemburg. This gift will bear the name of the "donation Biermans-Lapôtre," from the names of the doners, Mr. Biermans and Mrs. Biermans (née Lapôtre), who are of Dutch and Belgian origin, respectively. They are, however, residents of Canada, in which country their fortune was made.

Owing to the generosity of M. David Weill, the University of Paris will be able to grant this year five new scholarships of 6,000 francs each, for foreign study. These scholarships will be given to medical graduates who are preparing to teach.

Dr. Elbert F. Allen has been promoted to an assistant professorship of mathematics in the University of Missouri.

Dr. J. Stuart Foster, fellow in physics of the National Research Council, has been appointed assistant professor of physics at McGill University.

Dr. Ruth B. Howland and Dr. Ralph H. Cheney, instructors in the Washington Square College of New York University, have each been promoted to the rank of assistant professor in biology.

Robert L. Pendleton, Ph.D. (California '17), director of agriculture in Gwalior State, India, has been appointed professor of soil technology and in charge of the work in soils in the department of agronomy, College of Agriculture, University of the Philippines.

DISCUSSION AND CORRESPONDENCE

PRESENT STATUS OF METRIC SYSTEM IN THE UNITED STATES

In Science, April 18, 1924, p. 357, Professor A. B. Beaumont offers an admirable suggestion favoring the extension of the metric system. Briefly his plan is to have the Agricultural Experiment Stations plot their experimental fields in meters. The transition is easy and involves no expense since the meter is of the same order as the yard and because yields in kilograms per hectare approximate pounds per acre. (The difference is only 29 grams.)

Let it be noted in passing that while acre is a term frequently used, few persons can say how many square feet are in an acre. This in itself is quite a commentary on the irrationality of our land measures.

Beaumont further points out that "the meter is a little better than the yard for distances between large intertilled crops; and the *are* or *hectare* can easily be made to contain plants numbering multiples of ten, where an exact number of plants is desirable."

If this plan can be put into operation, it will bring

home to farmers and men in the fields generally the utility and simplicity of metric measures.

Scientific men the world over champion and use these units; also a large majority of the people of the world use them; but in two countries, Great Britain and the United States, arbitrary weights and measures continue in popular use. In the United States we use (and are duly grateful) a decimal coinage; but notwithstanding we find inch and ounce in use in kitchen, field and on the street. The low-brows remain deaf to the preachment of high-brows in laboratory and observatory. What then is to be done?

Radio is bringing into common use the meter, as the unit of wavelength; and electrical engineers measure current, energy and power in metric units; but mechanical engineers continue to think in foot-pounds, horse-power, etc. They are in the same class as the cooks. Now, both have their place in the divine economy and we would not underestimate their usefulness; but would we not rate their intelligence higher if "pinch," "spoonful," "sixteenth-of-an-inch," etc., gave way to grams in the kitchen and centimeters in the shop?

When such changes take place then without doubt school arithmetics will cease printing such paleozoic problems as "How many grains in 3 pwt.?" "What will 3/4 lb. of candy cost at 3 cents an oz.?"[1]

Evidently those of us who advocate the metric system must devise a method of conciliating cooks and converting carpenters!

ALEXANDER MCADIE

PHYSICS TEXT-BOOKS

THE protest against the use of loose definitions in physics texts which appeared in a recent issue of SCIENCE prompts me to call attention to other defects of text-books, which, to my mind, are even more serious than lack of rigor.

The recent researches in physics have done a great deal towards the correlation of physical facts and the unification of the whole field. It is now possible by logical deductions from very few principles and hypotheses to embrace the whole science of physics. To divide physics into the traditional mechanics, sound, heat, light and electricity, without showing how closely these branches are related to each other is inexcusable. But this is exactly what our texts do. Their attitude seems to be to keep secret the modern advances or, at least, to say nothing about the light that these advances throw on the subject. Our texts present scores of formulae and hundreds of facts, each of which seems to be separate from the rest. The various so-called gas laws, latent heat, specific heat, thermal expansion, are all still treated as if they had nothing in common. The kinetic theory of gases is treated as a curiosity in as many lines as the prony brake, for example, and with as much emphasis. The electrons are mentioned at the end of the part on electricity, and no attempt whatever is made to explain electrical phenomena in terms of the electron theory, although such an explanation would provide a clearer conception of what is taking place in an electrical conductor. The principle of conservation of energy is dismissed with a few short paragraphs at the beginning of the book, never to be mentioned again. The study of physics becomes an art of committing to memory a host of disconnected laws and facts.

The arrangement of the subject appears to be a cross between logical presentation and historical development. Needless to say, neither is attained. It is impossible nor is it desirable to present the elements of a science historically for beginners. While historical references are very useful, inasmuch as they stimulate the interest of the reader, chronological sequence of the advances of the subject must be sacrificed if coherent and logical presentation is to be attained. As it is, the failure of our texts to emphasize the unity of the subject together with the tendency to adhere to chronological sequence in the exposition results in the failure of the average student to see the connection between chapters. I have repeatedly asked my students whether they could see, without lectures, the logic underlying the sequence of chapters, and in the large majority of cases the reply was negative, although we have been using widely accepted text-books.

Not making use of the properties of electrons, atoms and molecules to explain physical phenomena the texts fail to make appeal to the imagination. The student gains no vivid picture of what is taking place in a gas or in an electrical conductor. The only readable part in an elementary book on physics are the applications of physical principles; the most interesting part, the theory, is there as a rule the most boring.

Much has been said concerning the dislike the average undergraduate has for physics. I have often wondered if a part at least of this attitude is not due to the old cut-and-dried way of dealing with the subject that our text-books have. Bare statements of facts and principles can give no inkling of the vitality of the subject of its problems, doubts and triumphs, and without conveying something of its romance the teaching of a science as thoroughly alive as physics can hardly be successful.

A. BLESS

UNIVERSITY OF MAINE

[1] These are actual problems found in a School Arithmetic opened at random. Also, "How many pills of 5 grains each can be made from 1 gram and 2 scruples of calomel?"

THE COLLEGE PROFESSOR AND HIS PAY

THE following extracts are from the preface of Professor Plotnikow's "Lehrbuch der Photochemie":

While devoting myself entirely to the study of photochemistry, I came gradually to the conviction that this new and rapidly growing field of research could no longer do without a thorough compilation of its literature and fundamental underlying principles. The production of a manual of photochemistry as complete as possible therefore seemed to be a scientific necessity in furthering investigations in this field. The first stone towards the realization of this structure was laid in 1910 with the publication of my "Photochemie." This was followed in 1912 by my "Versuchstechnik"; and in 1914 the manuscript of my "Photochemische Prakticum" was completed in Moscow. Thanks to the political situation existing at that time, this last work was never published. Some of its material, however, is embodied in the present "Text-book of Photochemistry," which endeavors to give the latest results together with the viewpoint and theories of this little investigated field, and which is now made accessible to those engaged in photochemical research as well as to those physicists and chemists interested in the phenomena of this branch of science.

Unfortunately the original plan of compiling and publishing a manual on the subject can not now be carried out, chiefly on account of the political events of the last five years linked to my own unfavorable personal circumstances. The historical material necessary was not at hand, and the libraries, the indispensable aid to every fundamental work, were no longer at my disposition. Moreover, my own experiences that affected deeply the trend of my speculative investigations were wholly of a negative nature; so that only through a struggle for self-forgetfulness and endurance was a way found to bring the work, even in much abbreviated form, to the light of day.

The composition of the present book and the working over of the great amount of accumulated material, was undertaken by me in the summer of 1917 at my country place "Schwartzer See" in the government of Riasan. All about the place swarmed bands of every breed of idle Russian folk. Day after day I was obliged to sit helplessly by and witness the violent plunder and destruction by the subordinates of Kerensky and Tscheonoff of my farm that had cost me so much pains, labor and money to bring to its high degree of economic production. Finally, in November of the same year the place was levelled to the ground. My private library was called upon to furnish cigarette papers. My family found asylum in a miserable little room in Moscow. Here under continuous artillery and musket fire of the Bolshevik insurrectionists, the constant fear inspired by them and the distress of hunger, the work on the book had to be carried on. Sad and toilsome enough were the hours so won for its composition. The scientific library that I had been years in collecting gradually melted away; for the books had to be exchanged for the daily bread to keep body and soul together. I had already been relieved of my position as university professor in the first days of the revolution (March 20, 1913) by the arbitrary, lawless and violent methods of the Minister of Education, Cadet Manuiloff, who could endure in educational positions only people of his particular political stripe. And so the first Russian laboratory for photochemistry that I had been at great pains, and partly at my own expense, to establish, was also abolished. As the food question became more and more acute, and as all sources began to fail, we fled in fear of our lives from this social paradise in the fall of 1918 to our relatives in the Ukraine. The mathematical part of the present work was done at Charkoff. But the Bolshevik wave of blood and hunger drew near and menaced also the rich and beautiful Ukraine, threatening its destruction and cutting me off again from the world of culture. In the name of the new social justice I have been made a wandering beggar, while others physically stronger than myself have been enriched at my expense; my scientific home was forfeited to me. Whether fate would again grant me such another home where I could carry on my scientific work quietly and unmolested seemed questionable; for, alas, among scientists party and national prejudice play a larger part than anywhere else. My position was indeed precarious. Then at last came help from Germany. Thanks to the timely interference of German scientific and technical men, it was made possible for me to go to Germany; and on Christmas, 1918, in Leipzig, to be surrounded by my German friends and well-wishers. Unfortunately, it was not possible for my wife and child to accompany me. They were obliged to remain in Charkoff; and thanks to the short-sighted and naïve policy of the entente for two years I was unable to communicate with my family.

But on German soil, so favorable to every scientific undertaking, it was made possible for me to bring to completion the present work. It is only a text-book, to be sure, and not a manual as originally planned; yet I believe it offers sufficient material to the present workers in this field to make possible further successful development in this so interesting scientific and practical line of research. I hope the book may be the means of adding to my old friends many new ones and that its unevenness of form and content may be attributed to their true cause. Never, I think, were the working out of new scientific problems attended by such unbearable conditions as those under which the present book was largely produced.

Hunger, misery, want, personal insecurity often approaching fear for one's life were the constant accompaniment of my labor; so that during the long time of its composition, the necessary repose for the mind and freedom from disturbance for thought were out of the question. Only the rigid will to rescue the offspring of my scientific activity from the surrounding chaos overcame the outward difficulties and provided the strength and inspiration for further effort, thus permitting me finally to bring to a favorable conclusion the correlated ideas resulting from my investigations.

F. W. STEVENS

WASHINGTON, D. C.

SCIENTIFIC BOOKS

The Elementary Principles of Lighting and Photometry. By JOHN W. T. WALSH. E. P. Dutton & Co., New York.

THE task which the author of this book has set himself is a very difficult and important one. The science and art of illumination has developed within recent years to such an extent that no one man can hope to be an expert in all its branches. Photometry, as a branch of physics, more particularly of radiometry, is a subject which in itself requires a book of considerable size for its adequate treatment. Light production is a branch of applied science calling for the most profound knowledge of physics and chemistry. The utilization of light—illuminating engineering—is a branch of engineering which is second to none in its importance in modern life, and because of the intertwining of engineering, ocular hygiene and esthetics involved, requires a very special talent and training. To present a survey of the whole subject of lighting which shall be truly informative, accurate and well balanced, requires, therefore, a rather exceptional fund of knowledge and experience, and the use of excellent judgment in the selection and presentation of material.

This task Mr. Walsh has performed in a very creditable way. The point of view of the book is well given in the statement that it "is mainly intended to give a description of the nature and amount of the illumination required for different purposes, and of the way in which the desired result may be attained and its attainment checked by photometric measurement." The book is written for readers who have an elementary scientific and technical education. It opens with a chapter on "Light, vision and the eye," in which the various factors involved in lighting are outlined. This is followed by chapters dealing with the measurement of candle power and illumination, together with some discussion of the characteristics of modern light sources. The practical aspects of illumination are then treated, under the headings of "Indoor lighting," "Industrial and school lighting," "Outdoor illumination," "Daylight illumination" and "Light projection."

In handling the measurement of light the author has made some radical departures from the ordinary treatment in text-books on photometry and certain of these departures are to be commended. Thus the whole subject of standards of light is very properly compressed into the statement that the standards consist of seasoned incandescent electric lamps which are preserved in the National Standardizing Laboratories and occasionally intercompared. This treatment deletes the usual lengthy discussion of the Hefner and other flame standards which are practically superseded. On the other hand, the rating of illuminants in terms of "average candle power" instead of lumens, as is the American practice, is open to criticism. The lumen is the exact analogue of the watt, and is an appropriate unit for the engineer. Its use tends to a clear understanding of the processes of transformation of energy involved in light production. In this connection it appears unfortunate that in his treatment of modern light sources Mr. Walsh has given no discussion of luminous efficiency, nor an adequate presentation of the physical characteristics of the radiations emitted. The fact that present-day light sources are only 2 or 3 per cent. efficient is of considerable economic interest, and the possibilities of improvement indicated by spectrum analysis of their radiations are among the most fascinating in modern applied science.

Mr. Walsh's treatment of photometric instruments and methods may be criticized in places as being too sketchy to give a clear idea to a reader not already familiar with the subject. For instance, the descriptions and illustrations of the Bunsen grease spot and the Lummer-Brodhun contrast photometers are much less clear than the excellent drawings in Liebenthal, which might easily have been copied. In his analysis of methods of colored light photometry Mr. Walsh is rather superficial. One gathers that the "cascade method" alone possesses the merit of averaging the results of a large group of observers; and the simple division of the subject into fundamental methods of evaluating luminosity differences in the presence of color and of auxiliary colored standards for practical use, calibrated by these fundamental methods, is quite lost sight of.

The treatment of color is in other respects not entirely satisfactory. His relegation of all questions of color to a late chapter on "Color in illumination and photometry" rather than their treatment early in the book, in connection with the physics of light production and the phenomena of color vision, does not seem a good arrangement. What the student of illumination needs is a knowledge of the spectral distribution of emission, in light sources, and of transmitting and reflecting power in material bodies, and the significance of these spectral characteristics in terms of color appearance. This latter calls for some knowledge of the elementary facts of color mixture. No knowledge of theories of color vision is really necessary, but if it is thought desirable to refer to any theories, it would appear to the reviewer that the Edridge Green theory, which Mr. Walsh selects, is the least useful in connection with the facts of color mixture and appearance just mentioned. The statement in the chapter on "Color" that a glass to simulate daylight in connection with a tungsten lamp has only recently been achieved must be interpreted, as is evidently the case for several statements of illumination practice, as applying to England, since daylight glass

has been an article of commerce in this country for some years.

In his treatment of the practical side of illumination Mr. Walsh gives primary emphasis to the problem of getting an adequate amount of light on the object or plane of interest; "the important factor in seeing is the brightness of the thing looked at and this is the product of the illumination and the reflection ratio." At the same time the almost equally important matter of keeping bright lights out of the field of vision, and the avoidance of glare in general are not lost sight of. Practically every important problem of lighting, in the home, the factory and the public institution, is treated in a manner sufficiently detailed so that the reader should have an intelligent idea of the fundamental requirements and the best practice in meeting these. The latest lighting legislation, both British and American, is extensively quoted.

The points to which exception has been taken are minor ones, and are such as are almost inevitable in any book which attempts to cover a large field. They do not prevent the book from giving, on the whole, an excellent view of the subject, and it can be cordially recommended to all who wish to obtain a good idea of the scope of modern lighting science and practice. The bibliography at the end is well chosen as a guide to further study of the subject. The book is excellently printed and attractively bound.

HERBERT E. IVES

WESTERN ELECTRIC COMPANY,
NEW YORK, N. Y.

SPECIAL ARTICLES

PROBABILITY-INCREASE IN SHUFFLING, AND THE ASYMMETRY OF TIME[1]

A MACROSCOPIC model to illustrate the nature of the Boltzmann H-theorem[2] has been described by P. and T. Ehrenfest. It will be recalled that the H-function is a measure of the probability P of a given state (configuration, velocity distribution) of a system of particles. It is related to the entropy S of the system through the relation $S = k \log P = -kH$. As the system approaches the steady state, the entropy S increases and the function H decreases, each approaching a limiting value. The Ehrenfest model, which operates by successive drafts of numbered tickets from urns, illustrates very effectively several characteristic properties of the H-function; in particular, its tendency to decrease continually when its value is remote from the ultimate "steady" value; the occasional lapses in which H momentarily increases, even in states remote from the steady state; the essentially discontinuous character of H, which, strictly speaking, renders the derivative (dH/dt) meaningless; and, finally, the small fluctuations of H above its minimum value when the statistically steady condition has become perceptibly established.[3]

One feature of special interest, however, the Ehrenfest model fails to exhibit, namely, the occurrence of long-continued and extended series of increases in H, such as must, according to the theorem, take place upon very rare occasions. Indeed, it seems at first sight hopeless to attempt to devise any experiment which should illustrate these exceptional high peaks in the H-curve. It seems like a contradiction of terms to speak of producing, at will, and within a closely limited period of time, an excessively rare (improbable) event. We know, indeed, that any truly representative model of an H-curve must have such high peaks at long intervals, corresponding, it may be, to billions of years or more; but how can we bring it about that such a peak shall occur during our experiment; that the particular piece of the curve under observation shall be the one containing the monstrosity?

By a simple artifice this effect can be secured. Two similar urns (boxes) are charged with a set of numbered tickets or the like. Box A receives tickets 1 to 50, which, for brevity, we may speak of as tickets a. Box B receives tickets 51 to 100, tickets b. The two boxes are thoroughly shaken to shuffle the tickets. A ticket is then drawn blindly from A, and another from B, the numbers drawn are recorded, and the tickets are returned to *opposite* urns. The urns are again thoroughly shaken and the same process is repeated as many time as may be desired. In the experiment here recorded, a series of 50 such double drafts was made.

At the termination of this first series of drafts the contents of box A are carefully noted. While this can be done from the records alone, as a matter of additional certainty, to guard against error, box A was opened and a note was made of all the tickets contained therein. They may, to distinguish them, be blackened on their back; but in any case it will now be convenient to speak of them as *black* tickets, while the remaining 50 tickets, contained in box B at the end of the first series, may be spoken of as white tickets.

The black tickets are put back in box A, and a second series of drafts precisely similar to the first is

[1] Papers from the Department of Biometry and Vital Statistics, School of Hygiene and Public Health, Johns Hopkins University, No. 91.

[2] P. and T. Ehrenfest, *Physikal Zeitschr.*, Vol. 8, 1907, p. 311; Schaefer, Einführung in die theoretische Physik, 1921, Vol. 2, p. 417.

[3] The experimental demonstration of the occurrence of these fluctuations near the steady state is one of the many remarkable developments of recent years in the physics of small dimensions. In this connection reference may be made to the work of The Svedberg (Die Existenz der Moleküle, Leipzig, 1912) and Smoluchowski (Bull. Acad. Cracovie, 1916, p. 218).

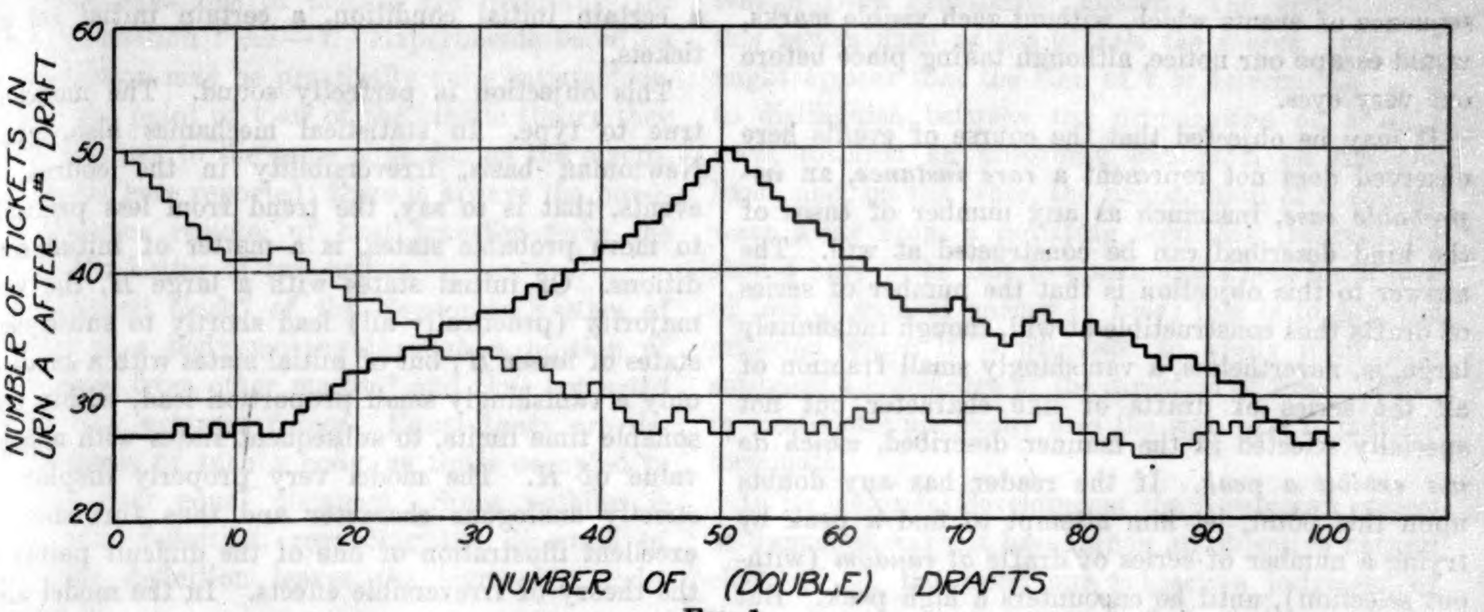

FIG. 1

now made. In the experiment here recorded the second series consisted, like the first, of 50 double drafts.

After the termination of the second series we may, by consulting the records, construct, first of all, a curve showing the tickets of kind *a* contained in box *A* at every step in the process that has been described. The lightly drawn curve shown in Fig. 1 was thus obtained. In general character it resembles the curve of the Ehrenfest model, and illustrates the same points of the *H*-theorem, no more and no less.

But if we now turn our attention to the *black* tickets (instead of tickets *a*), we see—herein lies the special interest of this method—that the method here followed enables us to trace the history of these tickets *backward* in time, from the moment (at the end of the first series) when they were all contained in box *A*. For, we know, from the record of the last draft in the first series, the numbers of all the *black* tickets; we can, therefore, go over the record of the first series of drafts and trace therein the previous history of all the black tickets, though at the time the drafts were made the identity of these black tickets was unknown to us. (We did not know, so to speak, which of the tickets were predestined to be black.)

The more heavily drawn curve of Fig. 1 shows the complete record of the history of the urn *A* as regards its contents of black tickets. The right half of this graph is, in general character, similar to the lightly drawn curve of Fig. 1. But the left half of the curve, the backwardly extended record of the history of the drafts, is the feature of special interest. It will be noted that during this part of the operation the system was *apparently* passing continually (with only occasional lapses) "from a more probable to a less probable state," until the process culminated, at the end of the first series, in the extremely "improbable"

TABLE I

NUMBER n OF TICKETS DRAWN r TIMES IN m DOUBLE DRAFTS ($2m$ INDIVIDUAL DRAFTS)

	n				
r	50 Drafts Calculated[4]	Drafts 1–50	Drafts[5] 51–100	100 Drafts Calculated[4]	Drafts 1–100
0	36.4	36	41	13.3	11
1	37.2	39	34	27.1	26
2	18.6	16	11	27.3	36
3	6.1	7	13	18.2	14
4	1.5	2	0	9.0	7
5	0.3	0	1	3.5	4
6	—	0	0	1.1	2
S[6]	28.2	27	26	25.3	28

$$n = \frac{m!}{(m-r)!\,r!}\left(\frac{1}{50}\right)^{r}\left(\frac{49}{50}\right)^{m-r}$$

where m = number of double drafts in the series, *i.e.*, 50 or 100.

condition in which all the black tickets were in one urn.

If the tickets found in urn *A* at the end of the first 50 drafts had been blackened *before* instead of after the 50th draft, the first series of drafts would appear to an observer absolutely miraculous, urn *A* becoming filled with black tickets by a sequence that would seem positively uncanny. Yet the blackening of the tickets in no way affects the physical course of events; it only serves to draw our attention to a

[4] Calculated according to the formula

[5] The second series of drafts (51–100) shows evidence of imperfect shuffling (excess of tickets drawn 0 times and 3 times).

[6] S denotes half the sum of the n's for even r's, *i.e.*, $\frac{n_0 + n_2 + n_4 + n_6}{2}$. It is equal to the number of those tickets present in urn *A* at the beginning of a series of drafts, which were again found in the same urn *A* also at the end of the series.

sequence of events which, without such visible marks, would escape our notice, although taking place before our very eyes.

It may be objected that the course of events here observed does not represent a *rare instance,* an *improbable case,* inasmuch as any number of cases of the kind described can be constructed at will. The answer to this objection is that the number of series of drafts thus constructible at will, though indefinitely large, is, nevertheless, a vanishingly small fraction of all the series of drafts of like character but not specially selected in the manner described, *which do not exhibit a peak.* If the reader has any doubts upon this point, let him attempt to find a peak by trying a number of series of drafts *at random* (without selection), until he encounters a high peak. But he should be warned that he will find this a time-consuming occupation. However, the experiment is unnecessary, for we can obtain an indirect estimate of the probability of success, as follows:

Suppose we attempt to name, by guessing, the 50 tickets that are going to be "black," *i.e.,* that will be found in urn A at the end of the 50th double draft. The chances are one in 2^{50} or one in 1,125,000,000,000,000 that we shall select all the 50 tickets correctly.

This way of looking at the matter has the advantage that it makes us independent of the physical similarity of the tickets. We may, if we please, blacken the selected tickets *before* shuffling and carrying out the series of drafts, or we may modify them in any way *before* the series, provided only that the modification is of such character as not to bias the shuffling process. Or, we may, for example, substitute balls for the tickets, and instead of blackening the selected 50 balls (those which we expect to observe as collecting in urn A at the end of the 50th draft), we may suppose them slightly increased or decreased in diameter, so as to render them distinct from the others, without, however, introducing any bias in favor of the selected balls collecting in urn A or in urn B. In any case our estimate remains true regarding our chance of guessing correctly, at the beginning of a series of 50 double drafts, upon which of the tickets we must fix our attention if we are to witness the remarkable spectacle of their segregation and assembling in urn A at the 50th draft.

It may now be objected that the series of drafts described is indeed an improbable one, but only in the sense that chances are very small that we should, without foreknowledge or knowledge *a posteriori,* select *initially* for observation a particular set of evenly distributed tickets which, at some subsequent time, are found to be all located in one urn.

In other words, it may be objected that what is improbable is not the series of drafts described, but the eventuality of fortuitously selecting for observation a certain initial condition, a certain initial set of tickets.

This objection is perfectly sound. The model is true to type. In statistical mechanics also, upon Newtonian basis, irreversibility in the course of events, that is to say, the trend from less probable to more probable states, is a matter of initial conditions. Of initial states with a large H, the vast majority (practically all) lead shortly to subsequent states of lesser H; but of initial states with a small H only a vanishingly small proportion lead, within reasonable time limits, to subsequent states with a large value of H. The model very properly displays a strictly analogous character and thus furnishes an excellent illustration of one of the difficult points in the theory of irreversible effects. In the model also, only a vanishingly small proportion of initial states in which the distribution of selected tickets is essentially even among the two urns, lead to subsequent states in which the distribution of the same tickets is very uneven (*e.g.,* all black tickets in one urn). On the contrary, a very large proportion (practically all) of the initial states in which the distribution of selected tickets is very uneven, lead shortly to subsequent states in which this distribution is essentially even.

It has been remarked that the law of evolution is the second law of thermodynamics; that an evolving system passes (in general) from less probable to more probable states.[7] The asymmetry of time has been identified with this property of evolving systems. In fact, it was for the purpose of furnishing a readily understood concrete illustration of this relation that the experiment described above was primarily designed by the writer, the original design covering only an operation of the nature of the first series of drafts described. Only when the possibility was recognized of extending the history of the tickets backward in time, by running two consecutive series, was it realized that the experiment is not competent to distinguish unequivocally between the forward and the backward direction in time. It may well be doubted whether any objective experiment can be devised that establishes, on the basis of classical mechanics or their analogue, a wholly unassailable distinction between the two directions in time. The

[7] J. Royce, Science, 1914, p. 551. It is doubtful whether a statement in such broad terms has any useful meaning. To give it such meaning it would seem necessary to specify *in what particular* a given state is more or less probable. An "improbable" state is a physically unstable state only if it is improbable with respect to a set of characteristics which, in undergoing change to a more probable set of values, furnishes an opportunity for obtaining work from the system by a macroscopic process.

There is an arbitrary element in any measure of "the probability of a given state of a system." It is only

Lagrangian equations of motion are invariant[8] for the transformation $t' = -t$. Experiments based on heat conduction may be practically quite satisfactory, but from the point of view of the kinetic theory they seem to be open to the same objection as the macroscopic model here reported; there is always the possibility, however remote, of heat transfer from the colder to the hotter of two bodies.

The "natural clock" of the Newtonian system of mechanics is a body moving through a portion of space remote from other matter,[9] and thus not acted upon by any external forces. Equal times are defined, in terms of such a body, as times occupied in the travel over equal distances. Since nothing is said, in this definition, regarding the *direction* of motion, the definition leaves the sign of t indeterminate.

The "natural clock" of the Einsteinian system is a ray of light propagated through a region of space remote from gravitating matter. The direction of this ray is fixed as *away from the source.* Here it might appear that the sign of t is determined. But to distinguish between the propagation of a light wave towards an absorbing oscillator, on the one hand, and, on the other, the propagation of a similar wave away from a radiating oscillator (source) we should have to be able to discriminate between a *rate* of loss or gain of energy *in time;* that is to say, the criterion which it is proposed to apply itself presupposes a knowledge of the direction of time. Thus, in relativistic mechanics also the sign of t is indeterterminate.

In its historical development the Newtonian system of dynamics was not based upon an objective natural clock at all, but upon our subjective judgment of time. For it is, of course, a fact, that we possess an intuitive, fairly accurate sense of equality in time intervals (rhythm), and a very deeply ingrained intuitive sense of the forward direction in time.[10] These are undoubtedly the ultimate foundations upon which the structure of dynamics was primarily reared, though the refinements of accurate clock indications were presently substituted for our approximate intuitive measures. This is, perhaps, as it should be. For the ultimate data of all observational science are psychological—sense perceptions, memory images and the like. To assume, as a starting point, an accurate mechanical clock with which our laboratory experiments in mechanics are timed, and thereupon to develop a system of mechanics which comprises in its scope the working of that very clock, seems a circular argument. The conclusions drawn, by such argument, regarding the mechanical properties of our clock (pendulum, earth, etc.) do not, of course, represent a new result; their real significance lies in the fact that they are found to lead to no conflict, thus proving that our assumptions involve no inherent contradictions, that the postulates admitted are competent to form the basis of a self-consistent system of dynamics. However, once this fact is established, we may adopt the system based on artificial time measurements, and disregard, as too coarse or imperfect, and, moreover, as unnecessary for the further devel-

with respect to certain *suitably defined* measures of probability that the entropy of the system has any significant relation to such probability. For example, it is unrelated to any "probability" that takes account of the mere identities ("personalities," so to speak) of the individual molecules of the same species.

There is here involved a question of fundamental principle. Probability is a subjective thing in so far as it depends upon the way in which we choose to classify phenomena or events. It is objective only in so far as our classification corresponds to objectively significant characters; among such we should hardly reckon, for example, the blackening of certain tickets, which would have practically no influence upon the physical course of events, but would merely serve to enable us to identify the members of a wholly arbitrary class. Indeed, we have here purposely selected a mode of marking which shall have no appreciable influence upon the draft. It is true that, as the result of this, our model illustrates primarily just those cases (such as the diffusion of a gas into itself) which are thermodynamically neutral; but indirectly, from the alternative point of view set forth above (based on the guessing of the black tickets), the model is equally representative of the typically dissipative processes accompanied by increase in entropy. For the mathematical probability of an event defined in any way is in itself independent of the thermodynamic significance or insignificance of that event, and we may, therefore, in all propriety, employ a thermodynamically insignificant event, following a certain law of probability, as a model to illustrate a thermodynamically significant event following the same or a similar law.

[8] H. Poincaré, "Thermodynamique," 1908, p. 441. Incidentally it may be noted that this holds true not only in Newtonian, but also in Einsteinian mechanics, owing to the fact that the velocity of light enters the fundamental equations of relativistic mechanics as the second power.

[9] H. Hertz, "Principien der Mechanik," 1894, p. 167; Webster, "Dynamics," 1912, p. 22.

[10] Curiously enough, our intuitive judgment of time, both as regards measure of intervals and as regards order of sequence, is vividly brought into play and strikingly exhibited in the art of music. As regards rhythm, this is obvious. But that we possess an entirely peculiar criterion of time-direction in our sense of chord resolution and of melodic progression has not, to my knowledge, been previously pointed out from this standpoint. Any one who may feel any doubt on the subject of this special sense of time-direction will find conviction in playing a phonograph record backward. Music rendered backward is an utterly meaningless jumble of noises. The same is not true of language (witness palindromes).

opment of the subject, the intuitive base from which we started. This is what the physicist, in effect, does, and his procedure finds pragmatic justification in the results.

It must be admitted that there is something unsatisfying to the mind in the conclusion that the distinction between the forward and the backward direction in time rests, physically, purely on a basis of probability. Intuition would lead us to look for a more fundamental difference. But if such there is, it escapes our present analytical scrutiny, our present analytical formulation of the laws of mechanics.[11]

A. J. LOTKA

THE JOHNS HOPKINS UNIVERSITY

THE NORTH CAROLINA ACADEMY OF SCIENCE

THE twenty-third annual meeting of the North Carolina Academy of Science was held at Trinity College, May 2 and 3. This was by far the best attended and most enthusiastic meeting the academy has ever held. The membership was reported as being 236, an increase of about ten per cent. for the year. More than half of the membership and many visitors were in attendance. The following papers were presented:

The ecological position of the eastern pine communities: B. W. WELLS.

A non-mathematical interpretation of the theory of relativity: W. W. WOOD.

Amoeboid behavior of the lymph cells in sea urchins: H. V. WILSON.

New dyes from amino-p-cymene: A. S. WHEELER and H. M. TAYLOR.

Studies in ascidian blood: W. C. GEORGE.

Extra area of hard surface due to widening roads around sharp curves: T. F. HICKERSON.

Identification trials: C. S. BRIMLEY.

Experiments on mental set: J. F. DASHIELL.

Evolution of the nesting habits of birds: Z. P. METCALF.

Present-day problems in engineering education: W. E. WICKENDEN.

Rainfall characteristics of North Carolina: T. SAVILLE and J. H. WULBERN.

Opportunities for chemical industries in North Carolina: E. E. RANDOLPH.

Local engineering problems in forestry: W. W. ASHE.

Brownian movements: F. P. VENABLE.

Improvements in the high school science situation: J. H. HIGHSMITH.

Variations in the proteins of corn: H. B. ARBUCKLE and O. J. THIERS, JR.

Soybean diseases: F. A. WOLFE.

New megachilid bees: T. B. MITCHELL.

Soft pork and its causes—I: J. O. HALVERSON and EARL HOSTETLER.

Methods for class demonstration of hydrogen sulfide formation by bacteria: I. V. SHUNK.

The hydrogen ion concentration of the intestines in relation to the intestinal protozoan parasites: M. J. HOGUE.

A botanical collecting trip up Grandfather's Mountain: P. O. SCHALLERT.

The biological determinant vs. the environmental determinant: C. C. TAYLOR.

The morphology of certain phylloxera galls on the hickory: A. C. MARTIN.

An American vs. a tubercle bacillus: CHARLES PHILLIPS.

Recent experiments on wintering honeybees: J. C. ECKERT.

The effect of dry heat on certain of the cotton seed: S. G. LEHMAN.

Vitality of albino rats for experimental purposes: F. W. SHERWOOD.

Injection of the blood vessels of young chick embryos: W. R. EARLE, presented by H. V. WILSON.

Water dogs (Necturus) of North Carolina: C. S. BRIMLEY.

A neglected factor in maze learning: J. F. DASHIELL.

Some results of soft pork investigation—II: J. O. HALVERSON and EARL HOSTETLER.

Structure of the heart muscle of Ascidia: W. C. GEORGE.

Homopterous head: Z. P. METCALF.

Gossypol in relation to nutrition: W. A. WITHERS.

Loess of the Yellow River district, China: COLLIER COBB.

A primitive gelatinous basidiomycete: W. C. COKER.

Observations on Pythium gracile, and on a fungus parasitic on it: J. N. COUCH.

Stream adjustment in loessal plan of China: COLLIER COBB.

A new aphanomyces parasitic on fungi: W. C. COKER and J. N. COUCH.

NORTH CAROLINA SECTION OF THE AMERICAN CHEMICAL SOCIETY

Latent heats of fusion of some nitrotoluenes as calculated from melting point depressions: J. M. BELL.

The action of phenylsemicarbazide on acetylacetone: A. S. WHEELER and F. P. BROOKS.

Devitrification of quartz ware: F. C. VILBRANDT.

The occurrence of borneol in spruce turpentine: A. S. WHEELER and C. R. HARRIS.

The chemical analysis of Okra seed (Hibiscus esculentus): B. NAIMAN and L. M. NIXON

New dyes derived from 2-amino-p-xylene: A. S. WHEELER and MILDRED MORSE.

A connection tube for gas burettes: F. C. VILBRANDT.

The action of amines on dichloro- and trichloroacetic acids: A. S. WHEELER and E. D. JENNINGS.

A solution of barium sulphate: O. J. THIES.

Some notes on gossypol: F. W. SHERWOOD.

NORTH CAROLINA PHYSICS TEACHERS' ASSOCIATION

Formation of molecules: W. E. SPEAS.

Scientific research in North Carolina: C. W. EDWARDS.

Pnysics laboratory manuals: W. T. WRIGHT.

11 Compare A. S. Eddington, Report on Relativity Theory of Gravitation, 1920, p. XI.

Secondary electrons produced by electronic bombardment of metals: D. A. WELLS and O. STUHLMAN, JR.

Liquefaction of gases: J. B. DERIEUX.

A compact form of the McLeod gauge: A. A. DIXON.

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

Symposium on the work of the investigating committee, Society for the Promotion of Engineering Education: Led by W. E. WICKENDEN.

Reports of the local committee on investigation and discussion of its work: Members of the committee, consisting of G. M. BRAUNE, *Chairman,* A. C. HOWELL, *Secretary,* C. W. EDWARDS, D. C. JACKSON, JR., H. B. SHAW, L. L. VAUGHN.

The teaching of English for engineers: T. P. HARRISON.

The following officers were elected by the academy for the ensuing year:

President: H. B. Arbuckle, Davidson College.
Vice-president: Miss Lulu G. Winston, Meredith College.
Secretary-Treasurer: Bert Cunningham, Trinity College.
Executive Committee: C. H. Heck, J. P. Givler, A. Henderson.

The following officers were elected by the North Carolina section of the American Chemical Society:

President: F. W. Sherwood.
Vice-president: M. L. Hamlin.
Secretary: L. B. Rhodes.
Councilor: J. M. Bell.

The mathematical section of the academy elected as chairman K. B. Patterson.

The North Carolina Physics Teachers Association deferred the election of officers to a later date.

BERT CUNNINGHAM,
Secretary

THE INDIANA ACADEMY OF SCIENCE

THE Indiana Academy of Science held its annual spring meeting at Marengo Cave on May 15 and 16. The largest crowd ever attending such a meeting was present, over one hundred twenty-eight persons being registered. Fortunately, the weather was very favorable for such a meeting.

On Thursday night following brief talks by Dr. W. M. Tucker on "The caves of Indiana" and by Dr. F. Payne on "Cave life," the party went through Marengo Cave.

At this meeting, Dr. C. H. Eigenmann, of Indiana University, was appointed a delegate to the Pan-American Science Conference to be held at Lima, Peru, on November 16. Dr. David A. Rothrock, of the department of mathematics of Indiana University, was appointed a delegate to the International Mathematical Congress, which is to be held at the University of Toronto from August 11 to 16.

A large number of representatives from other states were in attendance at these meetings. These were: Dr. C. H. Kennedy, Dr. E. N. Transeau, H. C. Sampson, Edward S. Thomas, Dr. R. C. Osburn, all of the Ohio State University, Columbus, Ohio; Dr. Carl L. Hubbs, Ann Arbor, Michigan; John C. Koch, White Pigeon, Michigan; Messrs. W. C. Croxton, P. A. Young, W. B. McDougall, J. B. Hawkes, O. Stark, all of the University of Illinois, Urbana, Illinois; Mr. V. T. Jackson, Chicago, Illinois; Mr. and Mrs. W. R. Allen, Lexington, Ky.; Mrs. Charles H. Baker, Kenasha, Wis.; Mr. Arthur A. Scheibenzuber, Mr. and Mrs. Ira T. Wilson, Mr. and Mrs. Claude E. Stout, all of Tiffin, Ohio.

On Friday morning a trip was made *via* auto to Wyandotte Cave. From Wyandotte the gathering divided into certain groups, some going to Corydon, the first capital of Indiana, to see the historical records, the old State Capitol and the old Constitutional elm. Another group, mostly zoologists and geologists, went to Mitchell, Indiana, to visit the caves in that region, particularly Donnelson's, which is owned by Indiana University.

HARRY F. DIETZ,
Press Secretary

THE KENTUCKY ACADEMY OF SCIENCE

THE academy held its eleventh annual meeting at the University of Kentucky, May 10, 1924, President W. R. Jillson presiding. The principal address was by Dr. L. C. Glenn, of Vanderbilt University, on the stratigraphy and structure of the western Kentucky coal field. Dr. Glenn described his work in this field, in connection with the Kentucky Geological Survey, and the conclusions reached.

The following program was rendered:

President's address: Geology of some proposed Kentucky state parks: W. R. JILLSON, state geologist, Frankfort.

Cumberland county oil horizons: LUCIEN BECKNER, Winchester.

Glacial pebbles in eastern Kentucky: W. R. JILLSON, Frankfort.

Geographic influences in the Kentucky knobs: W. G. BURROUGHS, Berea College.

The hydro-electric technical problems in the construction of the Dix River dam and power plant: JOHN S. VAN WINKLE, Danville.

Marine invasions in Pennsylvanian time in Eastern Kentucky. (By title): J. E. HUDNALL, Ky. Geological Survey, Frankfort.

The proportion and significance of iron, copper, manganese and zinc in some mollusks: J. S. MCHARGUE, Ky. Agricultural Experiment Station, Lexington.

Physiological balance and antagonism in nutrient solutions for wheat: SAM F. TRELEASE, University of Louisville.

The last wild pigeon in Kentucky: LUCIEN BECKNER, Winchester.

The mosses of Kentucky: GEO. D. SMITH, Eastern Kentucky State Normal School, Richmond.

Unit characters in poultry: W. S. ANDERSON and J. HOLMES MARTIN, College of Agriculture, University of Kentucky.

Geology of the Carter caves: W. R. JILLSON, Frankfort.

Influence of season of calving on milk and butter production of cows: J. J. HOOPER, College of Agriculture, University of Kentucky.

Farmers' earnings and standard of living in an agricultural area of northern Kentucky: W. D. NICHOLLS, College of Agriculture, University of Kentucky.

Laboratory apparatus for the dehydration of alcohol vapors by means of the Mariller system (By title): C. C. KIPLINGER and C. S. YUEH, Mt. Union College, Alliance, Ohio.

Harvard summer school of geology, Cumberland Gap, 1875: Col. M. H. CRUMP, Bowling Green.

The constitution was amended to increase the annual dues to $2.50. Resolutions were adopted approving the efforts of State Geologist Jillson to produce a complete topographical base map of the state; approving the work of the Society of Friends of Medical Progress; and sympathizing with Past-president A. M. Miller in his protracted illness.

Officers elected were: *President,* Professor Cloyd N. McAllister, Berea College; *vice-president,* Professor Sam F. Trelease, University of Louisville; *secretary,* A. M. Peter, University of Kentucky; *treasurer,* W. S. Anderson, University of Kentucky, Lexington; member of the publications committee, W. R. Jillson, Frankfort; representative in the council of the American Association for the Advancement of Science, A. M. Peter.

A. M. PETER,
Secretary.

LEXINGTON, KENTUCKY

THE AMERICAN MATHEMATICAL SOCIETY

THE two hundred and thirty-sixth regular meeting of the American Mathematical Society was held at Columbia University, on Saturday, May 3, 1924, extending through the usual morning and afternoon sessions. The attendance included 49 members of the society.

No meeting of the council was held. At the morning session of the society, three amendments to the by-laws were approved; the first concerned the elimination of ephemeral matter governing the business of the society during the period of incorporation, the second permitted the council to transact business by mail under certain restrictions, and the third introduced a new class of membership, to be known as sustaining membership.

At the beginning of the afternoon session, an address was delivered by Professor J. F. Ritt, at the request of the program committee, on "Rational substitutions."

The following papers were read:

The Dirichlet problem: NORBERT WIENER.

Analytic transformations of everywhere dense point sets: PHILIP FRANKLIN.

Functions with an isolated essential singularity: PHILIP FRANKLIN.

Concerning the sum of two bounded continua irreducible between the same pair of points: J. R. KLINE.

On extending a continuous (1–1) correspondence of two plane continuous curves to a correspondence of their planes: H. M. GEHMAN.

Treatise on basis sets: MARK KORMES.

Differential combinants. Preliminary report: O. E. GLENN.

A set of invariants connected with seven points on a gauche cubic: H. S. WHITE.

A characterization of a continuous curve: R. L. MOORE.

A theorem on continua: R. L. WILDER.

A general mean-value theorem: D. V. WIDDER.

Integro-differential invariants of one-parameter groups of projective transformations of function space. Preliminary report: A. D. MICHAL.

Systems of equations in an infinite number of unknowns whose solutions involve an arbitrary parameter: J. M. SHEFFER.

Mathematical theory of competition: C. F. ROOS.

The theory of testimony. Second paper: n witnesses: J. S. TAYLOR.

Rational substitutions: J. F. RITT.

Analytic functions and periodicity: J. F. RITT.

The curvature of space-time, the electromagnetic tensor, and radiation: G. Y. RAINICH.

Note on a special congruence: MALCOLM FOSTER.

Ricci's coefficients of rotation: HARRY LEVY.

The addition of quadratic differential forms: EDWARD KASNER.

Einstein solutions in space of seven dimensions: EDWARD KASNER.

Algebras which do not possess a finite basis: J. H. M. WEDDERBURN.

A theorem on simple algebras: J. H. M. WEDDERBURN.

Green's formula: H. E. BRAY.

Functions of plurisegments: A. J. MARIA.

The next regular meeting of the Society will be in New York City, October 25, 1924. On account of the International Mathematical Congress to be held in Toronto, there will be no summer meeting.

R. G. D. RICHARDSON,
Secretary